

## Key Topic 47: Filters

3-47F1 A good crystal band-pass filter for a single-sideband phone would be?

- A. 5 KHz.
- B. 2.1 KHz.
- C. 500 Hz.
- D. 15 KHz.

3-47F2 Which statement is true regarding the filter output characteristics shown in Figure 3F16?

- A. C is a low pass curve and B is a band pass curve.
- B. B is a high pass curve and D is a low pass curve.
- C. A is a high pass curve and B is a low pass curve.
- D. A is a low pass curve and D is a band stop curve.

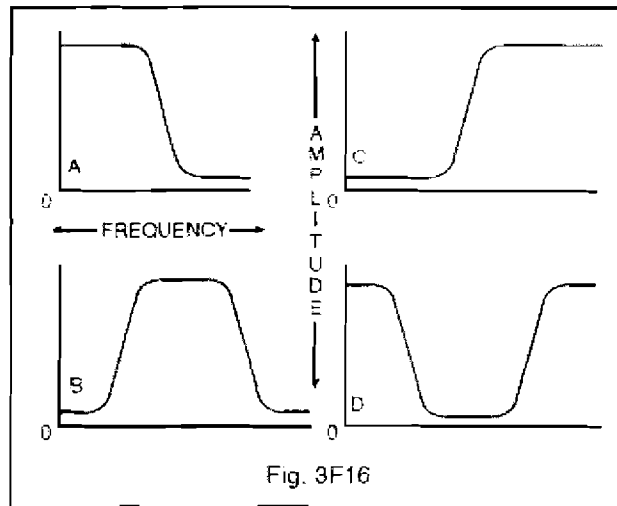


Fig. 3F16

3-47F3 What are the three general groupings of filters?

- A. High-pass, low-pass and band-pass.
- B. Inductive, capacitive and resistive.
- C. Audio, radio and capacitive.
- D. Hartley, Colpitts and Pierce.

3-47F4 What is an m-derived filter?

- A. A filter whose input impedance varies widely over the design bandwidth.
- B. A filter whose product of the series- and shunt-element impedances is a constant for all frequencies.
- C. A filter whose schematic shape is the letter "M".
- D. A filter that uses a trap to attenuate undesired frequencies too near cutoff for a constant-k filter.

3-47F5 What is an advantage of a constant-k filter?

- A. It has high attenuation of signals at frequencies far removed from the pass band.
- B. It can match impedances over a wide range of frequencies.
- C. It uses elliptic functions.
- D. The ratio of the cutoff frequency to the trap frequency can be varied.

3-47F6 What are the distinguishing features of a Butterworth filter?

- A. A filter whose product of the series- and shunt-element impedances is a constant for all frequencies.
- B. It only requires capacitors.
- C. It has a maximally flat response over its passband.
- D. It requires only inductors.

Answer Key: 3-47F1: B 3-47F2: D 3-47F3: A 3-47F4: D 3-47F5: A 3-47F6: C

## **Key Topic 48: Detectors**

3-48F1 What is a product detector?

- A. *It provides local oscillations for input to the mixer.*
- B. It amplifies and narrows the band-pass frequencies.
- C. It uses a mixing process with a locally generated carrier.
- D. It is used to detect cross-modulation products.

3-48F2 Which circuit is used to detect FM-phone signals?

- A. Balanced modulator.
- B. Frequency discriminator.
- C. Product detector.
- D. Phase splitter.

3-48F3 What is the process of detection in a radio diode detector circuit?

- A. Breakdown of the Zener voltage.
- B. Mixing with noise in the transition region of the diode.
- C. Rectification and filtering of RF.
- D. The change of reactance in the diode with respect to frequency.

3-48F4 What is a frequency discriminator in a radio receiver?

- A. A circuit for detecting FM signals.
- B. A circuit for filtering two closely adjacent signals.
- C. An automatic band switching circuit.
- D. An FM generator.

3-48F5 In a CTCSS controlled FM receiver, the CTCSS tone is filtered out after the:

- A. IF stage but before the mixer.
- B. Mixer but before the IF.
- C. IF but before the discriminator.
- D. Discriminator but before the audio section.

3-48F6 What is the definition of detection in a radio receiver?

- A. The process of masking out the intelligence on a received carrier to make an S-meter operational.
- B. The recovery of intelligence from the modulated RF signal.
- C. The modulation of a carrier.
- D. The mixing of noise with the received signal.

Answer Key: 3-48F1: C 3-48F2: B 3-48F3: C 3-48F4: A 3-48F5: D 3-48F6: B

## **Key Topic 49: Audio & Squelch Circuits**

- 3-49F1 What is the digital signal processing term for noise subtraction circuitry?
- A. *Adaptive filtering and autocorrelation.*
  - B. Noise blanking.
  - C. Noise limiting.
  - D. Auto squelch noise reduction.
- 3-49F2 What is the purpose of de-emphasis in the receiver audio stage?
- A. When coupled with the transmitter pre-emphasis, flat audio is achieved.
  - B. When coupled with the transmitter pre-emphasis, flat audio and noise reduction is received.
  - C. No purpose is achieved.
  - D. To conserve bandwidth by squelching no-audio periods in the transmission.
- 3-49F3 What makes a Digital Coded Squelch work?
- A. Noise.
  - B. Tones.
  - C. Absence of noise.
  - D. Digital codes.
- 3-49F4 What causes a squelch circuit to function?
- A. Presence of noise.
  - B. Absence of noise.
  - C. Received tones.
  - D. Received digital codes.
- 3-49F5 What makes a CTCSS squelch work?
- A. Noise.
  - B. Tones.
  - C. Absence of noise.
  - D. Digital codes.
- 3-49F6 What radio circuit samples analog signals, records and processes them as numbers, then converts them back to analog signals?
- A. The pre-emphasis audio stage.
  - B. The squelch gate circuit.
  - C. The digital signal processing circuit.
  - D. The voltage controlled oscillator circuit.

Answer Key: 3-49F1: A 3-49F2: B 3-49F3: D 3-49F4: A 3-49F5: B 3-49F6: C

## Key Topic 50: Receiver Performance

3-50F1 Where would you normally find a low-pass filter in a radio receiver?

- A. In the AVC circuit.
- B. In the Oscillator stage.
- C. In the Power Supply.
- D. A and C, but not B.

3-50F2 How can ferrite beads be used to suppress ignition noise? Install them:

- A. In the resistive high voltage cable every 2 years.
- B. Between the starter solenoid and the starter motor.
- C. Install them in the primary and secondary ignition leads.
- D. In the antenna lead.

3-50F3 What is the term used to refer to the condition where the signals from a very strong station are superimposed on other signals being received?

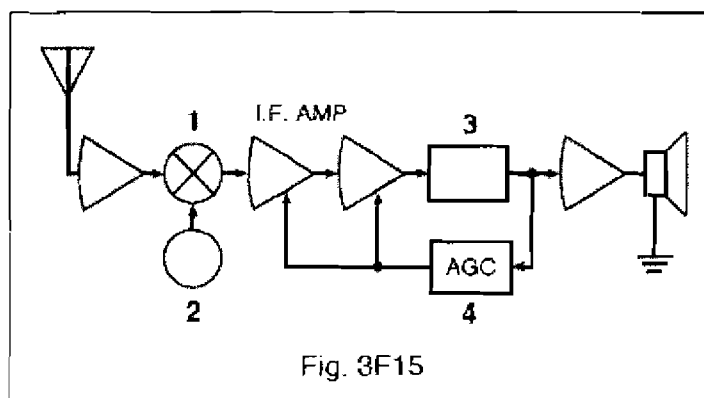
- A. Intermodulation distortion.
- B. Cross-modulation interference.
- C. Receiver quieting.
- D. Capture effect.

3-50F4 What is cross-modulation interference?

- A. Interference between two transmitters of different modulation type.
- B. Interference caused by audio rectification in the receiver preamp.
- C. Modulation from an unwanted signal heard in addition to the desired signal.
- D. Harmonic distortion of the transmitted signal.

3-50F5 In Figure 3F15 (EL3-D1) at what point in the circuit (labeled 1 through 4) could a DC voltmeter be used to monitor signal strength?

- A. 1
- B. 2
- C. 3
- D. 4



3-50F6 Pulse type interference to automobile radio receivers that appears related to the speed of the engine can often be reduced by:

- A. Installing resistances in series with spark plug wires.
- B. Using heavy conductors between the starting battery and the starting motor.
- C. Connecting resistances in series with the battery.
- D. Grounding the negative side of the battery.

Answer Key: 3-50F1: D 3-50F2: C 3-50F3: B 3-50F4: C 3-50F5: D 3-50F6: A

## Subelement G – Transmitters: 6 Key Topics, 6 Exam Questions

### Key Topic 51: Amplifiers-1

- 3-51G1 What class of amplifier is distinguished by the presence of output throughout the entire signal cycle and the input never goes into the cutoff region?
- A. Class A.
  - B. Class B.
  - C. Class C.
  - D. Class D.
- 3-51G2 What is the distinguishing feature of a Class A amplifier?
- A. Output for less than 180 degrees of the signal cycle.
  - B. Output for the entire 360 degrees of the signal cycle.
  - C. Output for more than 180 degrees and less than 360 degrees of the signal cycle.
  - D. Output for exactly 180 degrees of the input signal cycle.
- 3-51G3 Which class of amplifier has the highest linearity and least distortion?
- A. Class A.
  - B. Class B.
  - C. Class C.
  - D. Class AB.
- 3-51G4 Which class of amplifier provides the highest efficiency?
- A. Class A.
  - B. Class B.
  - C. Class C.
  - D. Class AB.
- 3-51G5 What class of amplifier is distinguished by the bias being set well beyond cutoff?
- A. Class A.
  - B. Class C.
  - C. Class B.
  - D. Class AB.
- 3-51G6 Which class of amplifier has an operating angle of more than 180 degrees but less than 360 degrees when driven by a sine wave signal?
- A. Class A.
  - B. Class B.
  - C. Class C.
  - D. Class AB.

Answer Key: 3-51G1: A 3-51G2: B 3-51G3: A 3-51G4: C 3-51G5: B 3-51G6: D

## **Key Topic 52: Amplifiers-2**

3-52G1 The class B amplifier output is present for what portion of the input cycle?

- A. 360 degrees.
- B. Greater than 180 degrees and less than 360 degrees.
- C. Less than 180 degrees.
- D. 180 degrees.

3-52G2 What input-amplitude parameter is most valuable in evaluating the signal-handling capability of a Class A amplifier?

- A. Average voltage.
- B. RMS voltage.
- C. Peak voltage.
- D. Resting voltage.

3-52G3 The class C amplifier output is present for what portion of the input cycle?

- A. Less than 180 degrees.
- B. Exactly 180 degrees.
- C. 360 degrees.
- D. More than 180 but less than 360 degrees.

3-52G4 What is the approximate DC input power to a Class AB RF power amplifier stage in an unmodulated carrier transmitter when the PEP output power is 500 watts?

- A. 250 watts.
- B. 600 watts.
- C. 800 watts.
- D. 1000 watts.

3-52G5 The class AB amplifier output is present for what portion of the input cycle?

- A. Exactly 180 degrees.
- B. 360 degrees
- C. More than 180 but less than 360 degrees.
- D. Less than 180 degrees.

3-52G6 What class of amplifier is characterized by conduction for 180 degrees of the input wave?

- A. Class A.
- B. Class B.
- C. Class C.
- D. Class D.

Answer Key: 3-52G1: D 3-52G2: C 3-52G3: A 3-52G4: D 3-52G5: C 3-52G6: B

### **Key Topic 53: Oscillators & Modulators**

3-53G1 What is the modulation index in an FM phone signal having a maximum frequency deviation of 3,000 Hz on either side of the carrier frequency when the modulating frequency is 1,000 Hz?

- A. 0.3
- B. 3,000
- C. 3
- D. 1,000

3-53G2 What is the modulation index of a FM phone transmitter producing a maximum carrier deviation of 6 kHz when modulated with a 2 kHz modulating frequency?

- A. 3
- B. 6,000
- C. 2,000
- D. 1

3-53G3 What is the total bandwidth of a FM phone transmission having a 5 kHz deviation and a 3 kHz modulating frequency?

- A. 3 kHz.
- B. 8 kHz.
- C. 5 kHz.
- D. 16 kHz.

3-53G4 How does the modulation index of a phase-modulated emission vary with RF carrier frequency?

- A. It does not depend on the RF carrier frequency.
- B. Modulation index increases as the RF carrier frequency increases.
- C. It varies with the square root of the RF carrier frequency.
- D. It decreases as the RF carrier frequency increases.

3-53G5 How can a single-sideband phone signal be generated?

- A. By driving a product detector with a DSB signal.
- B. By using a reactance modulator followed by a mixer.
- C. By using a loop modulator followed by a mixer.
- D. By using a balanced modulator followed by a filter.

3-53G6 What is a balanced modulator?

- A. An FM modulator that produces a balanced deviation.
- B. A modulator that produces a double sideband, suppressed carrier signal.
- C. A modulator that produces a single sideband, suppressed carrier signal.
- D. A modulator that produces a full carrier signal.

Answer Key: 3-53G1: C 3-53G2: A 3-53G3: D 3-53G4: A 3-53G5: D 3-53G6: B

## **Key Topic 54: Resonance - Tuning Networks**

3-54G1 What is an L-network?

- A. *A low power Wi-Fi RF network connection.*
- B. A network consisting of an inductor and a capacitor.
- C. A “lossy” network.
- D. A network formed by joining two low pass filters.

3-54G2 What is a pi-network?

- A. A network consisting of a capacitor, resistor and inductor.
- B. The Phase inversion stage.
- C. An enhanced token ring network.
- D. A network consisting of one inductor and two capacitors or two inductors and one capacitor.

3-54G3 What is the resonant frequency in an electrical circuit?

- A. The frequency at which capacitive reactance equals inductive reactance.
- B. The highest frequency that will pass current.
- C. The lowest frequency that will pass current.
- D. The frequency at which power factor is at a minimum.

3-54G4 Which three network types are commonly used to match an amplifying device to a transmission line?

- A. Pi-C network, pi network and T network.
- B. T network, M network and Z network.
- C. L network, pi network and pi-L network.
- D. L network, pi network and C network.

3-54G5 What is a pi-L network?

- A. A Phase Inverter Load network.
- B. A network consisting of two inductors and two capacitors.
- C. A network with only three discrete parts.
- D. A matching network in which all components are isolated from ground.

3-54G6 Which network provides the greatest harmonic suppression?

- A. L network.
- B. Pi network.
- C. Pi-L network.
- D. Inverse L network.

Answer Key: 3-54G1: B 3-54G2: D 3-54G3: A 3-54G4: C 3-54G5: B 3-54G6: C



## **Key Topic 55: SSB Transmitters**

3-55G1 What will occur when a non-linear amplifier is used with a single-sideband phone transmitter?

- A. Reduced amplifier efficiency.
- B. Increased intelligibility.
- C. Sideband inversion.
- D. Distortion.

3-55G2 To produce a single-sideband suppressed carrier transmission it is necessary to \_\_\_\_ the carrier and to \_\_\_\_ the unwanted sideband.

- A. Filter, filter.
- B. Cancel, filter.
- C. Filter, cancel.
- D. Cancel, cancel.

3-55G3 In a single-sideband phone signal, what determines the PEP-to-average power ratio?

- A. The frequency of the modulating signal.
- B. The degree of carrier suppression.
- C. The speech characteristics.
- D. The amplifier power.

3-55G4 What is the approximate ratio of peak envelope power to average power during normal voice modulation peak in a single-sideband phone signal?

- A. 2.5 to 1.
- B. 1 to 1.
- C. 25 to 1.
- D. 100 to 1.

3-55G5 What is the output peak envelope power from a transmitter as measured on an oscilloscope showing 200 volts peak-to-peak across a 50-ohm load resistor?

- A. 1,000 watts.
- B. 100 watts.
- C. 200 watts.
- D. 400 watts.

3-55G6 What would be the voltage across a 50-ohm dummy load dissipating 1,200 watts?

- A. 245 volts.
- B. 692 volts.
- C. 346 volts.
- D. 173 volts.

Answer Key: 3-55G1: D 3-55G2: B 3-55G3: C 3-55G4: A 3-55G5: B 3-55G6: A

## **Key Topic 56: Technology**

3-56G1 How can intermodulation interference between two transmitters in close proximity often be reduced or *eliminated*?

- A. By using a Class C final amplifier with high driving power.
- B. By installing a terminated circulator or ferrite isolator in the feed line to the transmitter and duplexer.
- C. By installing a band-pass filter in the antenna feed line.
- D. By installing a low-pass filter in the antenna feed line.

3-56G2 How can parasitic oscillations be eliminated in a power amplifier?

- A. By tuning for maximum SWR.
- B. By tuning for maximum power output.
- C. By neutralization.
- D. By tuning the output.

3-56G3 What is the name of the condition that occurs when the signals of two transmitters in close proximity mix together in one or both of their final amplifiers, and unwanted signals at the sum and difference frequencies of the original transmissions are generated?

- A. Amplifier desensitization.
- B. Neutralization.
- C. Adjacent channel interference.
- D. Intermodulation interference.

3-56G4 What term describes a wide-bandwidth communications system in which the RF carrier varies according to some pre-determined sequence?

- A. Spread-spectrum communication.
- B. AMTOR.
- C. SITOR.
- D. Time-domain frequency modulation.

3-56G5 How can even-order harmonics be reduced or prevented in transmitter amplifier design?

- A. By using a push-push amplifier.
- B. By operating class C.
- C. By using a push-pull amplifier.
- D. By operating class AB.

3-56G6 What is the modulation type that can be a frequency hopping of one carrier or multiple simultaneous carriers?

- A. SSB.
- B. FM.
- C. OFSK.
- D. Spread spectrum.

Answer Key: 3-56G1: B 3-56G2: C 3-56G3: D 3-56G4: A 3-56G5: C 3-56G6: D

## Subelement H – Modulation: 3 Key Topics, 3 Exam Questions, 1 Drawing

### Key Topic 57: Frequency Modulation

3-57H1 The deviation ratio is the:

- A. Audio modulating frequency to the center carrier frequency.
- B. Maximum carrier frequency deviation to the highest audio modulating frequency.
- C. Carrier center frequency to the audio modulating frequency.
- D. Highest audio modulating frequency to the average audio modulating frequency.

3-57H2 What is the deviation ratio for an FM phone signal having a maximum frequency deviation of plus or minus 5 kHz and accepting a maximum modulation rate of 3 kHz?

- A. 60
- B. 0.16
- C. 0.6
- D. 1.66

3-57H3 What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz and accepting a maximum modulation rate of 3.5 kHz?

- A. 2.14
- B. 0.214
- C. 0.47
- D. 47

3-57H4 How can an FM-phone signal be produced in a transmitter?

- A. By modulating the supply voltage to a class-B amplifier.
- B. By modulating the supply voltage to a class-C amplifier.
- C. By using a balanced modulator.
- D. By feeding the audio directly to the oscillator.

3-57H5 What is meant by the term modulation index?

- A. The ratio between the deviation of a frequency modulated signal and the modulating frequency.
- B. The processor index.
- C. The FM signal-to-noise ratio.
- D. The ratio of the maximum carrier frequency deviation to the highest audio modulating frequency.

3-57H6 In an FM-phone signal, what is the term for the maximum deviation from the carrier frequency divided by the maximum audio modulating frequency?

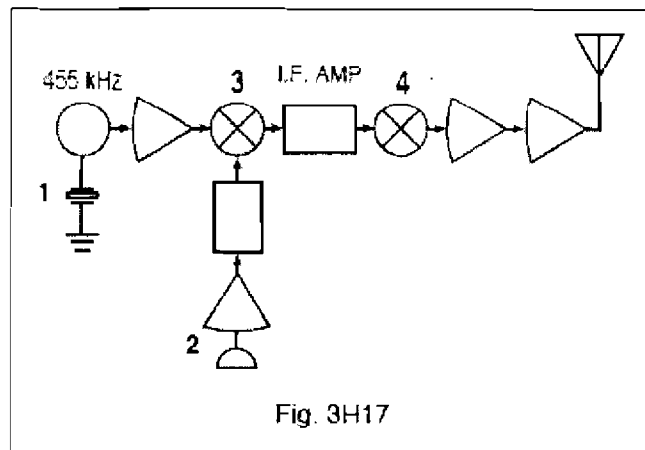
- A. Deviation index.
- B. Modulation index.
- C. Deviation ratio.
- D. Modulation ratio.

Answer Key: 3-57H1: B 3-57H2: D 3-57H3: A 3-57H4: D 3-57H5: A 3-57H6: C

## Key Topic 58: SSB Modulation

3-58H1 In Figure 3H17, the block labeled 4 would indicate that this schematic is most likely a/an:

- A. Audio amplifier.
- B. Shipboard RADAR.
- C. SSB radio transmitter.
- D. Wireless LAN (local area network) computer.



3-58H2 In Figure 3H17, which block diagram symbol (labeled 1 through 4) represents where audio intelligence is inserted?

- A. 1
- B. 2
- C. 3
- D. 4

3-58H3 What kind of input signal could be used to test the amplitude linearity of a single-sideband phone transmitter while viewing the output on an oscilloscope?

- A. Whistling in the microphone.
- B. An audio frequency sine wave.
- C. A two-tone audio-frequency sine wave.
- D. An audio frequency square wave.

3-58H4 What does a two-tone test illustrate on an oscilloscope?

- A. Linearity of a SSB transmitter.
- B. Frequency of the carrier phase shift.
- C. Percentage of frequency modulation.
- D. Sideband suppression.

3-58H5 How can a double-sideband phone signal be produced?

- A. By using a reactance modulator.
- B. By varying the voltage to the varactor in an oscillator circuit.
- C. By using a phase detector, oscillator, and filter in a feedback loop.
- D. By modulating the supply voltage to a class C amplifier.

3-58H6 What type of signals are used to conduct an SSB two-tone test?

- A. Two audio signals of the same frequency, but shifted 90 degrees in phase.
- B. Two non-harmonically related audio signals that are within the modulation band pass of the transmitter.
- C. Two different audio frequency square wave signals of equal amplitude.
- D. Any two audio frequencies as long as they are harmonically related.

Answer Key: 3-58H1: C 3-58H2: B 3-58H3: C 3-58H4: A 3-58H5: D 3-58H6: B

## **Key Topic 59: Pulse Modulation**

3-59H1 What is an important factor in pulse-code modulation using time-division multiplex?

- A. Synchronization of transmit and receive clock pulse rates.
- B. Frequency separation.
- C. Overmodulation and undermodulation.
- D. Slight variations in power supply voltage.

3-59H2 In a pulse-width modulation system, what parameter does the modulating signal vary?

- A. Pulse frequency.
- B. Pulse duration.
- C. Pulse amplitude.
- D. Pulse intensity.

3-59H3 What is the name of the type of modulation in which the modulating signal varies the duration of the transmitted pulse?

- A. Amplitude modulation.
- B. Frequency modulation.
- C. Pulse-height modulation.
- D. Pulse-width modulation.

3-59H4 Which of the following best describes a pulse modulation system?

- A. The peak transmitter power is normally much greater than the average power.
- B. Pulse modulation is sometimes used in SSB voice transmitters.
- C. The average power is normally only slightly below the peak power.
- D. The peak power is normally twice as high as the average power.

3-59H5 In a pulse-position modulation system, what parameter does the modulating signal vary?

- A. The number of pulses per second.
- B. The time at which each pulse occurs.
- C. Both the frequency and amplitude of the pulses.
- D. The duration of the pulses.

3-59H6 What is one way that voice is transmitted in a pulse-width modulation system?

- A. A standard pulse is varied in amplitude by an amount depending on the voice waveform at that instant.
- B. The position of a standard pulse is varied by an amount depending on the voice waveform at that instant.
- C. A standard pulse is varied in duration by an amount depending on the voice waveform at that instant.
- D. The number of standard pulses per second varies depending on the voice waveform at that instant.

Answer Key: 3-59H1: A 3-59H2: B 3-59H3: D 3-59H4: A 3-59H5: B 3-59H6: C

## Subelement I – Power Sources: 3 Key Topics, 3 Exam Questions

### Key Topic 60: Batteries-1

3-60I1 When a lead-acid storage battery is being charged, a harmful effect to humans is:

- A. Internal plate sulfation may occur under constant charging.
- B. Emission of oxygen.
- C. Emission of chlorine gas.
- D. Emission of hydrogen gas.

3-60I2 A battery with a terminal voltage of 12.5 volts is to be trickle-charged at a 0.5 A rate. What resistance should be connected in series with the battery to charge it from a 110-V DC line?

- A. 95 ohms.
- B. 300 ohms.
- C. 195 ohms.
- D. None of these.

3-60I3 What capacity in amperes does a storage battery need to be in order to operate a 50 watt transmitter for 6 hours? Assume a continuous transmitter load of 70% of the key-locked demand of 40 A, and an emergency light load of 1.5 A.

- A. 100 ampere-hours.
- B. 177 ampere-hours.
- C. 249 ampere-hours.
- D. None of these.

3-60I4 What is the total voltage when 12 Nickel-Cadmium batteries are connected in series?

- A. 12 volts.
- B. 12.6 volts.
- C. 15 volts.
- D. 72 volts.

3-60I5 The average fully-charged voltage of a lead-acid storage cell is:

- A. 1 volt.
- B. 1.2 volts.
- C. 1.56 volts.
- D. 2.06 volts.

3-60I6 A nickel-cadmium cell has an operating voltage of about:

- A. 1.25 volts.
- B. 1.4 volts.
- C. 1.5 volts.
- D. 2.1 volts.

Answer Key: 3-60I1: D 3-60I2: C 3-60I3: B 3-60I4: C 3-60I5: D 3-60I6: A

## **Key Topic 61: Batteries-2**

3-61I1 When an emergency transmitter uses 325 watts and a receiver uses 50 watts, how many hours can a 12.6 volt, 55 ampere-hour battery supply full power to both units?

- A. 1.8 hours.
- B. 6 hours.
- C. 3 hours.
- D. 1.2 hours.

3-61I2 What current will flow in a 6 volt storage battery with an internal resistance of 0.01 ohms, when a 3-watt, 6-volt lamp is connected?

- A. 0.4885 amps.
- B. 0.4995 amps.
- C. 0.5566 amps.
- D. 0.5795 amps.

3-61I3 A ship RADAR unit uses 315 watts and a radio uses 50 watts. If the equipment is connected to a 50 ampere-hour battery rated at 12.6 volts, how long will the battery last?

- A. 1 hour 43 minutes.
- B. 28.97 hours.
- C. 29 minutes.
- D. 10 hours, 50 minutes.

3-61I4 If a marine radiotelephone receiver uses 75 watts of power and a transmitter uses 325 watts, how long can they both operate before discharging a 50 ampere-hour 12 volt battery?

- A. 40 minutes.
- B. 1 hour.
- C. 1 1/2 hours.
- D. 6 hours.

3-61I5 A 6 volt battery with 1.2 ohms internal resistance is connected across two light bulbs in parallel whose resistance is 12 ohms each. What is the current flow?

- A. 0.57 amps.
- B. 0.83 amps.
- C. 1.0 amps.
- D. 6.0 amps.

3-61I6 A 12.6 volt, 8 ampere-hour battery is supplying power to a receiver that uses 50 watts and a RADAR system that uses 300 watts. How long will the battery last?

- A. 100.8 hours.
- B. 27.7 hours.
- C. 1 hour.
- D. 17 minutes or 0.3 hours.

Answer Key: 3-61I1: A 3-61I2: B 3-61I3: A 3-61I4: C 3-61I5: B 3-61I6: D

## **Key Topic 62: Motors & Generators**

3-62I1 What occurs if the load is removed from an operating series DC motor?

- A. It will stop running.
- B. Speed will increase slightly.
- C. No change occurs.
- D. It will accelerate until it falls apart.

3-62I2 If a shunt motor running with a load has its shunt field opened, how would this affect the speed of the motor?

- A. It will slow down.
- B. It will stop suddenly.
- C. It will speed up.
- D. It will be unaffected.

3-62I3 The expression “voltage regulation” as it applies to a shunt-wound DC generator operating at a constant frequency refers to:

- A. Voltage fluctuations from load to no-load.
- B. Voltage output efficiency.
- C. Voltage in the secondary compared to the primary.
- D. Rotor winding voltage ratio

3-62I4 What is the line current of a 7 horsepower motor operating on 120 volts at full load, a power factor of 0.8, and 95% efficient?

- A. 4.72 amps.
- B. 13.03 amps.
- C. 56 amps.
- D. 57.2 amps.

3-62I5 A 3 horsepower, 100 V DC motor is 85% efficient when developing its rated output. What is the current?

- A. 8.545 amps.
- B. 20.345 amps.
- C. 26.300 amps.
- D. 25.000 amps.

3-62I6 The output of a separately-excited AC generator running at a constant speed can be controlled by:

- A. The armature.
- B. The amount of field current.
- C. The brushes.
- D. The exciter.

Answer Key: 3-62I1: D 3-62I2: C 3-62I3: A 3-62I4: D 3-62I5: C 3-62I6: B



## Subelement J – Antennas: 5 Key Topics, 5 Exam Questions

### Key Topic 63: Antenna Theory

- 3-63J1 Which of the following could cause a high standing wave ratio on a transmission line?
- A. Excessive modulation.
  - B. An increase in output power.
  - C. A detuned antenna coupler.
  - D. Low power from the transmitter.
- 3-63J2 Why is the value of the radiation resistance of an antenna important?
- A. Knowing the radiation resistance makes it possible to match impedances for maximum power transfer.
  - B. Knowing the radiation resistance makes it possible to measure the near-field radiation density from transmitting antenna.
  - C. The value of the radiation resistance represents the front-to-side ratio of the antenna.
  - D. The value of the radiation resistance represents the front-to-back ratio of the antenna.
- 3-63J3 A radio frequency device that allows RF energy to pass through in one direction with very little loss but absorbs RF power in the opposite direction is a:
- A. Circulator.
  - B. Wave trap.
  - C. Multiplexer.
  - D. Isolator.
- 3-63J4 What is an advantage of using a trap antenna?
- A. It may be used for multiband operation.
  - B. It has high directivity in the high-frequency bands.
  - C. It has high gain.
  - D. It minimizes harmonic radiation.
- 3-63J5 What is meant by the term radiation resistance of an antenna?
- A. Losses in the antenna elements and feed line.
  - B. The specific impedance of the antenna.
  - C. The resistance in the trap coils to received signals.
  - D. An equivalent resistance that would dissipate the same amount of power as that radiated from an antenna.
- 3-63J6 What is meant by the term antenna bandwidth?
- A. Antenna length divided by the number of elements.
  - B. The frequency range over which an antenna can be expected to perform well.
  - C. The angle between the half-power radiation points.
  - D. The angle formed between two imaginary lines drawn through the ends of the elements.

Answer Key: 3-63J1: C 3-63J2: A 3-63J3: D 3-63J4: A 3-63J5: D 3-63J6: B

## **Key Topic 64: Voltage, Current and Power Relationships**

3-64J1 What is the current flowing through a 52 ohm line with an input of 1,872 watts?

- A. 0.06 amps.
- B. 6 amps.
- C. 28.7 amps.
- D. 144 amps.

3-64J2 The voltage produced in a receiving antenna is:

- A. Out of phase with the current if connected properly.
- B. Out of phase with the current if cut to 1/3 wavelength.
- C. Variable depending on the station's SWR.
- D. Always proportional to the received field strength.

3-64J3 Which of the following represents the best standing wave ratio (SWR)?

- A. 1:1.
- B. 1:1.5.
- C. 1:3.
- D. 1:4.

3-64J4 At the ends of a half-wave antenna, what values of current and voltage exist compared to the remainder of the antenna?

- A. Equal voltage and current.
- B. Minimum voltage and maximum current.
- C. Maximum voltage and minimum current.
- D. Minimum voltage and minimum current.

3-64J5 An antenna radiates a primary signal of 500 watts output. If there is a 2nd harmonic output of 0.5 watt, what attenuation of the 2nd harmonic has occurred?

- A. 10 dB.
- B. 30 dB.
- C. 40 dB.
- D. 50 dB.

3-64J6 There is an improper impedance match between a 30 watt transmitter and the antenna, with 5 watts reflected. How much power is actually radiated?

- A. 35 watts.
- B. 30 watts.
- C. 25 watts.
- D. 20 watts.

Answer Key: 3-64J1: B 3-64J2: D 3-64J3: A 3-64J4: C 3-64J5: B 3-64J6: C

## **Key Topic 65: Frequency and Bandwidth**

- 3-65J1 A vertical  $1/4$  wave antenna receives signals:
- A. In the microwave band.
  - B. In one vertical direction.
  - C. In one horizontal direction.
  - D. Equally from all horizontal directions.
- 3-65J2 The resonant frequency of a Hertz antenna can be lowered by:
- A. Lowering the frequency of the transmitter.
  - B. Placing an inductance in series with the antenna.
  - C. Placing a condenser in series with the antenna.
  - D. Placing a resistor in series with the antenna.
- 3-65J3 An excited  $1/2$  wavelength antenna produces:
- A. Residual fields.
  - B. An electro-magnetic field only.
  - C. Both electro-magnetic and electro-static fields.
  - D. An electro-flux field sometimes.
- 3-65J4 To increase the resonant frequency of a  $1/4$  wavelength antenna:
- A. Add a capacitor in series.
  - B. Lower capacitor value.
  - C. Cut antenna.
  - D. Add an inductor.
- 3-65J5 What happens to the bandwidth of an antenna as it is shortened through the use of loading coils?
- A. It is increased.
  - B. It is decreased.
  - C. No change occurs.
  - D. It becomes flat.
- 3-65J6 To lengthen an antenna electrically, add a:
- A. Coil.
  - B. Resistor.
  - C. Battery.
  - D. Conduit.

Answer Key: 3-65J1: D      3-65J2: B      3-65J3: C      3-65J4: A      3-65J5: B      3-65J6: A

## **Key Topic 66: Transmission Lines**

3-66J1 What is the meaning of the term velocity factor of a transmission line?

- A. *The ratio of the characteristic impedance of the line to the terminating impedance.*
- B. The velocity of the wave on the transmission line divided by the velocity of light in a vacuum.
- C. The velocity of the wave on the transmission line multiplied by the velocity of light in a vacuum.
- D. The index of shielding for coaxial cable.

3-66J2 What determines the velocity factor in a transmission line?

- A. The termination impedance.
- B. The line length.
- C. Dielectrics in the line.
- D. The center conductor resistivity.

3-66J3 Nitrogen is placed in transmission lines to:

- A. Improve the “skin-effect” of microwaves.
- B. Reduce arcing in the line.
- C. Reduce the standing wave ratio of the line.
- D. Prevent moisture from entering the line.

3-66J4 A perfect (no loss) coaxial cable has 7 dB of reflected power when the input is 5 watts. What is the output of the transmission line?

- A. 1 watt.
- B. 1.25 watts.
- C. 2.5 watts.
- D. 5 watts.

3-66J5 Referred to the fundamental frequency, a shorted stub line attached to the transmission line to absorb even harmonics could have a wavelength of:

- A. 1.41 wavelength.
- B. 1/2 wavelength.
- C. 1/4 wavelength.
- D. 1/6 wavelength.

3-66J6 If a transmission line has a power loss of 6 dB per 100 feet, what is the power at the feed point to the antenna at the end of a 200 foot transmission line fed by a 100 watt transmitter?

- A. 70 watts.
- B. 50 watts.
- C. 25 watts.
- D. 6 watts.

Answer Key: 3-66J1: B      3-66J2: C      3-66J3: D      3-66J4: A      3-66J5: C      3-66J6: D

## **Key Topic 67: Effective Radiated Power**

3-67J1 What is the effective radiated power of a repeater with 50 watts transmitter power output, 4 dB feedline loss, 3 dB duplexer and circulator loss, and 6 dB antenna gain?

- A. 158 watts.
- B. 39.7 watts.
- C. 251 watts.
- D. 69.9 watts.

3-67J2 What is the effective radiated power of a repeater with 75 watts transmitter power output, 4 dB feedline loss, 3 dB duplexer and circulator loss, and 10 dB antenna gain?

- A. 600 watts.
- B. 75 watts.
- C. 18.75 watts.
- D. 150 watts.

3-67J3 What is the effective radiated power of a repeater with 75 watts transmitter power output, 5 dB feedline loss, 4 dB duplexer and circulator loss, and 6 dB antenna gain?

- A. 37.6 watts.
- B. 237 watts.
- C. 150 watts.
- D. 23.7 watts.

3-67J4 What is the effective radiated power of a repeater with 100 watts transmitter power output, 4 dB feedline loss, 3 dB duplexer and circulator loss, and 7 dB antenna gain?

- A. 631 watts.
- B. 400 watts.
- C. 25 watts.
- D. 100 watts.

3-67J5 What is the effective radiated power of a repeater with 100 watts transmitter power output, 5 dB feedline loss, 4 dB duplexer and circulator loss, and 10 dB antenna gain?

- A. 126 watts.
- B. 800 watts.
- C. 12.5 watts.
- D. 1260 watts.

3-67J6 What is the effective radiated power of a repeater with 50 watts transmitter power output, 5 dB feedline loss, 4 dB duplexer and circulator loss, and 7 dB antenna gain?

- A. 300 watts.
- B. 315 watts.
- C. 31.5 watts.
- D. 69.9 watts.

Answer Key: 3-67J1: B 3-67J2: D 3-67J3: A 3-67J4: D 3-67J5: A 3-67J6: C

## Subelement 3-K – Aircraft: 6 Key Topics, 6 Exam Questions

### **Key Topic 68: Distance Measuring Equipment**

3-68K1 What is the frequency range of the Distance Measuring Equipment (DME) used to indicate an aircraft's slant range distance to a selected ground-based navigation station?

- A. 108.00 MHz to 117.95 MHz.
- B. 108.10 MHz to 111.95 MHz.
- C. 962 MHz to 1213 MHz.
- D. 329.15 MHz to 335.00 MHz.

3-68K2 The Distance Measuring Equipment (DME) measures the distance from the aircraft to the DME ground station. This is referred to as:

- A. DME bearing.
- B. The slant range.
- C. Glide Slope angle of approach.
- D. Localizer course width.

3-68K3 The Distance Measuring Equipment (DME) ground station has a built-in delay between reception of an interrogation and transmission of the reply to allow:

- A. Someone to answer the call.
- B. The VOR to make a mechanical hook-up.
- C. Operation at close range.
- D. Clear other traffic for a reply.

3-68K4 What is the main underlying operating principle of an aircraft's Distance Measuring Equipment (DME)?

- A. A measurable amount of time is required to send and receive a radio signal through the Earth's atmosphere.
- B. The difference between the peak values of two DC voltages may be used to determine an aircraft's distance to another aircraft.
- C. A measurable frequency compression of an AC signal may be used to determine an aircraft's altitude above the earth.
- D. A phase inversion between two AC voltages may be used to determine an aircraft's distance to the exit ramp of an airport's runway.

3-68K5 What radio navigation aid determines the distance from an aircraft to a selected VORTAC station by measuring the length of time the radio signal takes to travel to and from the station?

- A. RADAR.
- B. Loran C.
- C. Distance Marking (DM).
- D. Distance Measuring Equipment (DME).

3-68K6 The majority of airborne Distance Measuring Equipment systems automatically tune their transmitter and receiver frequencies to the paired \_\_\_ / \_\_\_ channel.

- A. VOR/marker beacon.
- B. VOR/LOC.
- C. Marker beacon/glideslope.
- D. LOC/glideslope.

Answer Key: 3-68K1: C 3-68K2: B 3-68K3: C 3-68K4: A 3-68K5: D 3-68K6: B

## **Key Topic 69: VHF Omnidirectional Range (VOR)**

3-69K1 All directions associated with a VOR station are related to:

- A. Magnetic north.
- B. North pole.
- C. North star.
- D. None of these.

3-69K2 The rate that the transmitted VOR variable signal rotates is equivalent to how many revolutions per second?

- A. 60
- B. 30
- C. 2400
- D. 1800

3-69K3 What is the frequency range of the ground-based Very-high-frequency Omnidirectional Range (VOR) stations used for aircraft navigation?

- A. 108.00 kHz to 117.95 kHz.
- B. 329.15 MHz to 335.00 MHz.
- C. 329.15 kHz to 335.00 kHz.
- D. 108.00 MHz to 117.95 MHz.

3-69K4 Lines drawn from the VOR station in a particular magnetic direction are:

- A. Radials.
- B. Quadrants.
- C. Bearings.
- D. Headings.

3-69K5 The amplitude modulated variable phase signal and the frequency modulated reference phase signal of a Very-high-frequency Omnidirectional Range (VOR) station used for aircraft navigation are synchronized so that both signals are in phase with each other at \_\_\_\_\_ of the VOR station.

- A. 180 degrees South, true bearing position.
- B. 360 degrees North, magnetic bearing position.
- C. 180 degrees South, magnetic bearing position.
- D. 0 degrees North, true bearing position.

3-69K6 What is the main underlying operating principle of the Very-high-frequency Omnidirectional Range (VOR) aircraft navigational system?

- A. A definite amount of time is required to send and receive a radio signal.
- B. The difference between the peak values of two DC voltages may be used to determine an aircraft's altitude above a selected VOR station.
- C. A phase difference between two AC voltages may be used to determine an aircraft's azimuth position in relation to a selected VOR station.
- D. A phase difference between two AC voltages may be used to determine an aircraft's distance from a selected VOR station.

Answer Key: 3-69K1: A 3-69K2: B 3-69K3: D 3-69K4: A 3-69K5: B 3-69K6: C

## **Key Topic 70: Instrument Landing System (ILS)**

3-70K1 What is the frequency range of the localizer beam system used by aircraft to find the centerline of a runway during an Instrument Landing System (ILS) approach to an airport?

- A. 108.10 kHz to 111.95 kHz.
- B. 329.15 MHz to 335.00 MHz.
- C. 329.15 kHz to 335.00 kHz.
- D. 108.10 MHz to 111.95 MHz.

3-70K2 What is the frequency range of the marker beacon system used to indicate an aircraft's position during an Instrument Landing System (ILS) approach to an airport's runway?

- A. The outer, middle, and inner marker beacons' UHF frequencies are unique for each ILS equipped airport to provide unambiguous frequency-protected reception areas in the 329.15 to 335.00 MHz range.
- B. The outer marker beacon's carrier frequency is 400 MHz, the middle marker beacon's carrier frequency is 1300 MHz, and the inner marker beacon's carrier frequency is 3000 MHz.
- C. The outer, the middle, and the inner marker beacon's carrier frequencies are all 75 MHz but the marker beacons are 95% tone-modulated at 400 Hz (outer), 1300 Hz (middle), and 3000 Hz (inner).
- D. The outer, marker beacon's carrier frequency is 3000 kHz, the middle marker beacon's carrier frequency is 1300 kHz, and the inner marker beacon's carrier frequency is 400 kHz.

3-70K3 Which of the following is a required component of an Instrument Landing System (ILS)?

- A. Altimeter: shows aircraft height above sea-level.
- B. Localizer: shows aircraft deviation horizontally from center of runway.
- C. VHF Communications: provide communications to aircraft.
- D. Distance Measuring Equipment: shows aircraft distance to VORTAC station.

3-70K4 What type of antenna is used in an aircraft's Instrument Landing System (ILS) glideslope installation?

- A. A vertically polarized antenna that radiates an omnidirectional antenna pattern.
- B. A balanced loop reception antenna.
- C. A folded dipole reception antenna.
- D. An electronically steerable phased-array antenna that radiates a directional antenna pattern.

3-70K5 Choose the only correct statement about the localizer beam system used by aircraft to find the centerline of a runway during an Instrument Landing System (ILS) approach to an airport. The localizer beam system:

- A. Operates within the assigned frequency range of 108.10 to 111.95 GHz.
- B. Produces two amplitude modulated antenna patterns; one pattern above and one pattern below the normal 2.5 degree approach glide path of the aircraft.
- C. Frequencies are automatically tuned-in when the proper glide slope frequency is selected on the aircraft's Navigation and Communication (NAV/COMM) transceiver.
- D. Produces two amplitude modulated antenna patterns; one pattern with an audio frequency of 90 Hz and one pattern with an audio frequency of 150 Hz, one left of the runway centerline and one right of the runway centerline.

3-70K6 On runway approach, an ILS Localizer shows:

- A. Deviation left or right of runway center line.
- B. Deviation up and down from ground speed.
- C. Deviation percentage from authorized ground speed.
- D. Wind speed along runway.

Answer Key: 3-70K1: D 3-70K2: C 3-70K3: B 3-70K4: C 3-70K5: D 3-70K6: A



## **Key Topic 71: Automatic Direction Finding Equipment (ADF) & Transponders**

3-71K1 What is the frequency range of an aircraft's Automatic Direction Finding (ADF) equipment?

- A. 190 kHz to 1750 kHz.
- B. 190 MHz to 1750 MHz.
- C. 108.10 MHz to 111.95 MHz.
- D. 108.00 MHz to 117.95 MHz.

3-71K2 What is meant by the term "night effect" when using an aircraft's Automatic Direction Finding (ADF) equipment? Night effect refers to the fact that:

- A. All Non Directional Beacon (NDB) transmitters are turned-off at dusk and turned-on at dawn.
- B. Non Directional Beacon (NDB) transmissions can bounce-off the Earth's ionosphere at night and be received at almost any direction.
- C. An aircraft's ADF transmissions will be slowed at night due to the increased density of the Earth's atmosphere after sunset.
- D. An aircraft's ADF antennas usually collect dew moisture after sunset which decreases their effective reception distance from an NDB transmitter.

3-71K3 What are the transmit and receive frequencies of an aircraft's mode C transponder operating in the Air Traffic Control RADAR Beacon System (ATCRBS)?

- A. Transmit at 1090 MHz, and receive at 1030 MHz
- B. Transmit at 1030 kHz, and receive at 1090 kHz
- C. Transmit at 1090 kHz, and receive at 1030 kHz
- D. Transmit at 1030 MHz, and receive at 1090 MHz

3-71K4 In addition to duplicating the functions of a mode C transponder, an aircraft's mode S transponder can also provide:

- A. Primary RADAR surveillance capabilities.
- B. Long range lightning detection.
- C. Mid-Air collision avoidance capabilities.
- D. Backup VHF voice communication abilities.

3-71K5 What type of encoding is used in an aircraft's mode C transponder transmission to a ground station of the Air Traffic Control RADAR Beacon System (ATCRBS)?

- A. Differential phase shift keying.
- B. Pulse position modulation.
- C. Doppler effect compressional encryption.
- D. Amplitude modulation at 95%.

3-71K6 Choose the only correct statement about an aircraft's Automatic Direction Finding (ADF) equipment.

- A. An aircraft's ADF transmission exhibits primarily a line-of-sight range to the ground-based target station and will not follow the curvature of the Earth.
- B. Only a single omnidirectional sense antenna is required to receive an NDB transmission and process the signal to calculate the aircraft's bearing to the selected ground station.
- C. All frequencies in the ADF's operating range except the commercial standard broadcast stations (550 to 1660 kHz) can be utilized as a navigational Non Directional Beacon (NDB) signal.
- D. An aircraft's ADF antennas can receive transmissions that are over the Earth's horizon (sometimes several hundred miles away) since these signals will follow the curvature of the Earth.

Answer Key: 3-71K1: A 3-71K2: B 3-71K3: A 3-71K4: C 3-71K5: B 3-71K6: D